



# **F-35 Lightning II Joint Strike Fighter (JSF) Program: Background, Status, and Issues**

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## Summary

The Defense Department's F-35 Lightning II Joint Strike Fighter (JSF) is one of three aircraft modernization programs in tactical aviation, the others being the Air Force F-22A fighter and the Navy F/A-18E/F fighter/attack plane. In November 1996, the Defense Department selected two major aerospace companies, Boeing and Lockheed Martin, to demonstrate competing designs for the JSF, a joint-service and multi-role fighter/attack plane. Lockheed Martin won this competition and was selected to develop and produce the JSF, a family of aircraft including conventional take-off and landing (CTOL), carrier-capable (CV), and short take-off vertical landing (STOVL) versions for the U.S. Air Force, Navy, and Marine Corps, the United Kingdom, as well as other allied services. Originally designated the Joint Advanced Strike Technology (JAST) program, the JSF program has attracted considerable attention in Congress because of concerns about its cost, effects on the defense industrial base, and implications for U.S. national security in the 21<sup>st</sup> century.

The JAST/JSF program is designed to address the high cost of tactical aviation, the need to deploy fewer types of aircraft to reduce acquisition and operating costs, and projections of future threat scenarios and enemy capabilities. The program's rationale and primary emphasis is joint-service development of a next-generation multi-role strike aircraft that can be produced in affordable variants to meet different operational requirements. Developing an affordable tri-service family of aircraft with different (but similar) combat missions poses major technological challenges. If the JSF is to have joint-service support, the program must yield affordable aircraft that can meet such divergent needs as those of the U.S. Air Force for a successor to its low-cost F-16 and A-10 fighter/attack planes, those of the U.S. Marine Corps and the UK Royal Air Force and Navy for a successor to their Harrier STOVL aircraft, and the U.S. Navy's need for a successor to older F/A-18s and a complement to its F/A-18E/F fighter/attack planes.

This report discusses the background, status, and current issues of the JSF program. Additional information and analysis can be found in CRS Report RL33543, *Tactical Aircraft Modernization: Issues for Congress*, by Christopher Bolkcom, which also discusses the Air Force F-22A, the Navy F/A-18EF, and select unmanned aerial vehicles (UAVs). The JSF program is also addressed in CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*, by Anthony Murch and Christopher Bolkcom; CRS Report RS21488, *Navy-Marine Corps Tactical Air Integration Plan: Background and Issues for Congress*, by Christopher Bolkcom and Ronald O'Rourke; and CRS Report RL31360, *Joint Strike Fighter (JSF): Potential National Security Questions Pertaining to a Single Production Line*, by Christopher Bolkcom and Daniel H. Else.

This report will be updated as events warrant.

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## Introduction

The F-35 *Lightning II*, Joint Strike Fighter (JSF) program is developing and building a family of next-generation tactical aircraft for the Air Force, the Marine Corps, and the Navy, as well as for export.<sup>1</sup> As now projected, the JSF is the Defense Department's (DOD's) largest acquisition program in terms of cost and number of aircraft to be produced and the longest in terms of procurement duration. Current DOD plans call for production of 2,456 aircraft in three versions over a 28-year delivery period.<sup>2</sup>

The U.S. Air Force's program of record is to purchase 1,763 conventional takeoff and landing (CTOL) versions of the F-35 to replace its current force of F-16 *Falcons* and A-10 *Warhogs*. In February 2003, Air Force officials announced its intentions to analyze acquisition of the STOVL JSF to improve future close air support (CAS) capabilities.<sup>3</sup> To date, however, the Air Force has not committed to purchasing other variants besides its CTOL platform. While speculation continues as to the procurement intentions of the USAF (the largest purchaser of the F-35), the Air Force official position still remains at 1,763 CTOL F-35s.<sup>4</sup>

The Department of the Navy (composed of the Navy and the Marine Corps) plans to procure of 680 JSFs. The Marine Corps plans to field the short take-off vertical landing (STOVL) version of the plane to replace its current fleet of AV-8B *Harrier* vertical/short take-off and landing (VSTOL) attack planes.<sup>5</sup> The Navy plans to procure a carrier-capable version—termed a CV—to replace older carrier-based aircraft. The exact division of the Department's 680 F-35s between the two variants and the two services has not yet been determined.

An additional 738 aircraft are expected to be ordered by the JSF development partner nations of the UK, Australia, Italy, Canada, Denmark, Turkey, the Netherlands, and Norway.<sup>6</sup> The United Kingdom is anticipated to be the largest foreign purchaser of the F-35, with a projected 138 STOVL aircraft.

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<sup>1</sup> Unlike the F-22A *Raptor*, the F-35 was designed for export from the onset and will be the first U.S. export of a stealth aircraft.

<sup>2</sup> Fifteen of these aircraft will be purchased with RDT&E funds and will be used for developmental testing.

<sup>3</sup> Lorenzo Cortes, "Air Force to Study Acquisition of F-35-B STOVL JSF," *Defense Daily*, February 13, 2004; Gail Kaufman, "U.S. Air Force Wants STOVL JSFs," *Defense News*, February 12, 2004; and Christopher Castelli, "Overall Impact of Air Force Interest in F-35 STOVL Variant is Unclear," *Inside the Navy*, March 1, 2004.

<sup>4</sup> Marc Selinger, "Jumper Confirms Air Force Plans to Cut Joint Strike Fighter Purchase," *Aerospace Daily & Defense Report*, December 15, 2004.

<sup>5</sup> The U.S. Marine Corps and the UK Royal Navy and Royal Air Force operate versions of the AV-8A/B *Harrier* aircraft flown by these services since the early 1970s. CRS Report 81-180, *The British Harrier V/STOL Aircraft: Analysis of Operational Experience and Relevance to U.S. Tactical Aviation* (out of print; available from the author at 7-2577).

<sup>6</sup> Current anticipated partner orders: UK: 138; Italy: 131; Australia: 100; Turkey: 100; Canada: 88; Netherlands: 85; Denmark: 48; Norway: 48. Michael Sirak, "F-35 Nations on Track to Sign New MOU, Says JSF Program Office," *Defense Daily*, November 20, 2006.

**Figure 1. F-35 Lightning II Joint Strike Fighter**



## **Background**

The JSF program emerged in late 1995 from the Joint Advanced Strike Technology (JAST) program, which began in late 1993 as a result of the Administration's Bottom-Up Review (BUR) of U.S. defense policy and programs. Having affirmed plans to abandon development of both the A-12/AFX aircraft that was to replace the Navy's A-6 attack planes and the multi-role fighter (MRF) that the Air Force had considered to replace its F-16s, the BUR envisaged the JAST program as a replacement for both these programs. In 1995, in response to congressional direction, a program led by the Defense Advanced Research Projects Agency (DARPA) to develop an advanced short takeoff and vertical landing (ASTOVL) aircraft was incorporated into the JAST program. This opened the way for Marine Corps and British Navy participation.<sup>7</sup> The name of the program was then changed to Joint Strike Fighter to focus on joint development and production of a next-generation fighter/attack plane. And unlike the so-called "joint" Air Force/Navy TFX program of the 1960s, program proponents note the JAST/JSF program has been truly "joint" from its inception.

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<sup>7</sup> Since the early 1990s, DARPA had funded various STOVL projects expected to develop aircraft to replace both U.S. Marine Corps AV-8B Harriers and the UK Royal Navy's Sea Harriers. The merger of these research-development efforts with the JAST program in early 1995 cleared the way for U.S.-UK collaboration in JSF development.

During the JAST/JSF program's 1994-1996 concept development phase, three different aircraft designs were proposed by Boeing, Lockheed Martin, and McDonnell Douglas (the latter teamed with Northrop Grumman and British Aerospace) in a competitive program expected to shape the future of U.S. tactical aviation and the U.S. defense industrial base.<sup>8</sup> On November 16, 1996, the Defense Department announced that Boeing and Lockheed Martin had been chosen to compete in the 1997-2001 concept demonstration phase, in which each contractor would build and flight-test two aircraft to demonstrate their concepts for three JSF variants (conventional takeoff/landing, short-field takeoff/vertical landing, and the carrier takeoff/landing). On October 26, 2001, DOD selected a team of contractors led by Lockheed Martin to develop and produce the JSF. The three variants—CTOL, CV and STOVL aircraft—are to have maximum commonality in airframe, engine, and avionics components to reduce development, production, and operation and support costs.

Mainly because of their projected costs, three tactical aircraft programs are being analyzed by both Congress and the Administration to determine the best combination of the types and numbers of aircraft to meet the future needs of the military—the emergent JSF program, the Air Force F-22A program, and the Navy's F/A-18E/F program. Congressional decisions on these programs will have important implications for defense funding requirements, U.S. military capabilities, and the U.S. aerospace industry.

## Design and Performance

Contrary to some misconceptions that the Joint Strike Fighter would be one aircraft used by several services for different missions, the program focused on the development and production of three variants with common components: a land-based conventional take-off and landing (CTOL) version for the Air Force, a carrier-based version (CV) for the Navy, and a short take-off vertical landing (STOVL) version for the Marines and the UK. The JSF program is a family of aircraft performing similar missions, with a mix of components, systems, and technologies. Component commonality among the three variants is projected to be at 70% to 90%.<sup>9</sup> Many of the high-cost components are common, including engines, avionics, and major structural components of the airframe. Former Secretary of Defense William Cohen stated that the JSF's joint approach "avoids the three parallel development programs for service-unique aircraft that would have otherwise been necessary, saving at least \$15 billion."<sup>10</sup>

The JSF will be powered by the Pratt & Whitney F135 engine, which was derived from the F-22A's Pratt & Whitney F119 power plant. Consistent with congressional direction in 1996, DOD established an alternative engine program (F136), with the General Electric/Rolls-Royce Fighter Engine Team, to compete with the F135 for JSF production and operations and support (O&S) contracts. In addition to teaming up with GE on the F136 engine, Rolls-Royce is contracted to develop and produce the STOVL lift fan system that will be used with both the F135 and F136 engines. The net cost-benefit of an alternate engine for the JSF program has periodically been

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<sup>8</sup> John Tirpak, "Strike Fighter," *Air Force Magazine*, October 1996, pp. 22-28; Philip Hough, "An Aircraft for the 21<sup>st</sup> Century," *Sea Power*, November 1996, pp. 33-34.

<sup>9</sup> Operational Requirements call for 70% to 90% commonality between all variants. Lockheed Martin notes currently that over 80% of all parts are common on all three variants. Clarence A. Robinson, Jr., "A New Fighter Paradigm," *F-35 Lightning II Commemorating First Flight*.

<sup>10</sup> Letter from Secretary of Defense William S. Cohen to Rep. Jerry Lewis, June 22, 2000. Transcript made available by *Inside the Airforce*, June 23, 2000.

debated, and DOD has attempted to eliminate funding for the F136 (removing funding for the engine in the FY2007, FY2008, and FY2009 budget requests).<sup>11</sup> Congress has acted multiple times throughout the program's history to ensure continued DOD support for the F136.

All JSF planes will be fifth-generation, single-engine, single-seat aircraft with supersonic dash capability and some degree of stealth (low observability to radar and other sensors).<sup>12</sup> Combat ranges and payloads will vary in the different service variants. For example, as currently planned, combat radius requirements are 590-690 nautical miles (nm) for the Air Force, 600-730 nm for the Navy, and 450-550 nm for the Marine Corps. All three variants are planned to carry weapons internally (two 2,000 lb. weapons for the CTOL and CV variant and two 1,000 lb. weapons for the STOVL) to maintain a stealthy radar signature.<sup>13</sup> Weapons can also be carried externally. All versions will also carry AIM-120 AMRAAMs (advanced medium-range air-to-air missiles, with a range of about 26 nm/48 km depending on altitude<sup>14</sup>). General Dynamics is under contract to develop the 25mm gun for the F-35.<sup>15</sup>

Performance features regarding radar signature, speed, range, and payload were determined on the basis of trade-offs between performance and cost, with the latter being a critical factor. Program officials have emphasized that cost and performance trade-offs are critical elements of the program, and were the basis for the joint-service operational requirements that determined the selection of the Lockheed Martin contractor team for the System Development and Demonstration (SDD) phase.<sup>16</sup> The 1997 Quadrennial Defence Review (QDR) report observed that "Uncertainties in prospective JSF production cost warrant careful Departmental oversight of the cost-benefit tradeoffs in design to ensure that modernization and force structure remain in balance over the long term."<sup>17</sup> In other words, production costs must be low enough that these aircraft can be bought in sufficient quantities to maintain desired force levels. Thus, the parameters of the JSF's performance and operational capabilities are subject to refinement for reasons of cost, technological developments, and future threat assessments.<sup>18</sup>

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<sup>11</sup> See CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*, by Anthony Murch and Christopher Bolkcom, for more information. Also see "Dual Engine Development Could Saddle JSF with up to \$800 Million Bill," *Inside the Navy*, August 5, 1996, p. 2; "Despite Demand for Second JSF Engine Source, F120 Comes up Short," *Aerospace Daily*, October 18, 1996, p. 102; U.S. Congressional Budget Office, *A Look at Tomorrow's Tactical Air Forces* by Lane Pierrot and Jo Ann Vines, January 1997, p. 53.

<sup>12</sup> Fifth-generation fighters combine new developments such as thrust vectoring, composite materials, supercruise, stealth technology, advanced radar and sensors, and integrated avionics to greatly improve pilot situational awareness. Currently, only the F-22 and F-35 are considered fifth-generation. Russia has a fifth-generation fighter under development and it is due for its first flight in 2009.

<sup>13</sup> The STOVL variant weapons load was reduced to assist with overall aircraft weight reduction efforts in 2004. Background information provided by the F-35 Joint Program Office, September 2007.

<sup>14</sup> Steven Zaloga, "AIM-120 AMRAAM," *World Missiles Briefing*, Teal Group Corp., January 1997, p. 5.

<sup>15</sup> "Marina Malenic. "DoD Poised to Approve Buy of 17 More F-35s; STOVL in Limbo Awaiting Engine Test." *Defense Daily*. November 25, 2008..

<sup>16</sup> "Tradeoffs Will Be Made to Contain JSF Costs," *Aerospace Daily*, September 26, 1997, p. 469.

<sup>17</sup> U.S. Department of Defense, *Report of the Quadrennial Defense Review* [by] William S. Cohen, Secretary of Defense, May 1997, p. 46.

<sup>18</sup> The Joint Program Office notes that the F-35's Key Performance Parameters (KPPs) have not changed since Milestone B in 2001.



## Program Management

The JSF program is jointly staffed and managed by the Department of the Air Force and the Department of the Navy (comprising the Navy and the Marine Corps), with coordination among the services reinforced by alternating Air Force and Navy Department officials in key management positions. For example, Lt. General George Muellner, USAF, was the program's first director in 1994, with Rear Admiral Craig Steidle, USN, serving as deputy director. Subsequently, Rear Admiral Steidle directed the program, with Brigadier General Leslie Kenne, USAF, as his deputy in late 1996 and his successor as program director in August 1997. The current director is Maj. Gen. Charles Davis, USAF. Service Acquisition Executive (SAE) responsibility also alternates, with the Air Force having that responsibility when the program director is from the Navy Department, and the Navy in that role with an Air Force director of the program.

In 2004, appropriations conferees followed a House recommendation to direct DOD to review this alternative management arrangement. House appropriators believed that "management of program acquisition should remain with one Service, and that the U.S. Navy, due to its significant investment in two variants of the F-35 should be assigned all acquisition executive oversight responsibilities."<sup>19</sup> Conferees directed that DOD submit a report on the potential efficacy of this change. Prior to the release of the DOD report, former Air Force Chief of Staff General Jumper was quoted as saying that he also supported putting one service in charge of JSF program acquisition.<sup>20</sup> However, General Jumper highlighted the significant investment the Air Force was making in the JSF program in response to the congressional language favoring the Navy. In DOD's response to Congress, the report noted the current arrangement ensures one Service does not have a "disproportionate voice" when it comes to program decisions and that the current system is "responsive, efficient, and in the best interests of the success of the JSF program."<sup>21</sup> Since DOD's response to Congress in 2004, the issue of JSF program management has not been raised.

## Funding and Projected Costs

The Defense Department's quarterly Selected Acquisition Report of December 25, 2007, estimated the JSF program at \$298.8 billion in then-year dollars for 2,456 aircraft, which equates to a program acquisition unit cost (PAUC) of \$121.6 million per aircraft. The average procurement cost (APUC) (which does not include R&D or other costs) is estimated at \$103.9 million per aircraft. The December 2005 SAR noted that the JSF program breached a "Nunn-McCurdy" cost growth limit: unit cost growth over 30% of the original Acquisition Program Baseline.<sup>22</sup> The December 2007 PAUC and APUC cost estimates are, respectively, 38.8% and 38.0% higher than cost estimates made in October 2001.

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<sup>19</sup> H.Rept. 108-553 (H.R. 4613), p. 234

<sup>20</sup> Elizabeth Rees, "Jumper Supports Single Service Retaining JSF Acquisition Oversight," *Inside the Air Force*, August 6, 2004.

<sup>21</sup> U.S. Department of Defense, *Report to Congress on Joint Strike Fighter Management Oversight* [forwarded by] Michael W. Wynne, Under Secretary of Defense for Acquisition, Technology and Logistics, December 20, 2004.

<sup>22</sup> JSF program breach of Nunn-McCurdy was also reported and addressed in the 2003 SAR. The FY2006 National Defense Authorization Act directed a change in reporting based on the "original" Acquisition Program Baseline resulting in a second breach of Nunn-McCurdy.

Since 2002, the JSF program estimate has increased by \$100 billion due primarily to a one-year extension in the program's System Development and Demonstration phase, a corresponding one-year delay in procurement (from FY2006 to FY2007), revised annual quantity profiles, and revised labor and overhead rates.<sup>23</sup> Much of this increased cost and schedule slippage was incurred to address weight-driven performance issues in the development of the F-35B, the STOVL variant.

DOD's FY2009 budget requested \$6.9 billion in JSF funding. As it did in FY2007 and in FY2008, DOD proposed to eliminate funding for the F136 Alternate Engine. The proposed termination of the F136 drew considerable scrutiny in the 109<sup>th</sup> Congress (second session) and 110<sup>th</sup> Congress (first session). Congress stipulated in the 2008 National Defense Authorization Act (NDAA) (P.L. 110-181, Sec 213)<sup>24</sup>:

The Secretary of Defense was to "ensure the obligation and expenditure in each such fiscal year of sufficient annual amounts for the continued development and procurement of two options for the propulsion system for the Joint Strike Fighter."

A summary of FY2009 congressional action on the F-35 begins on page 12 of this report.

## Development and Schedule

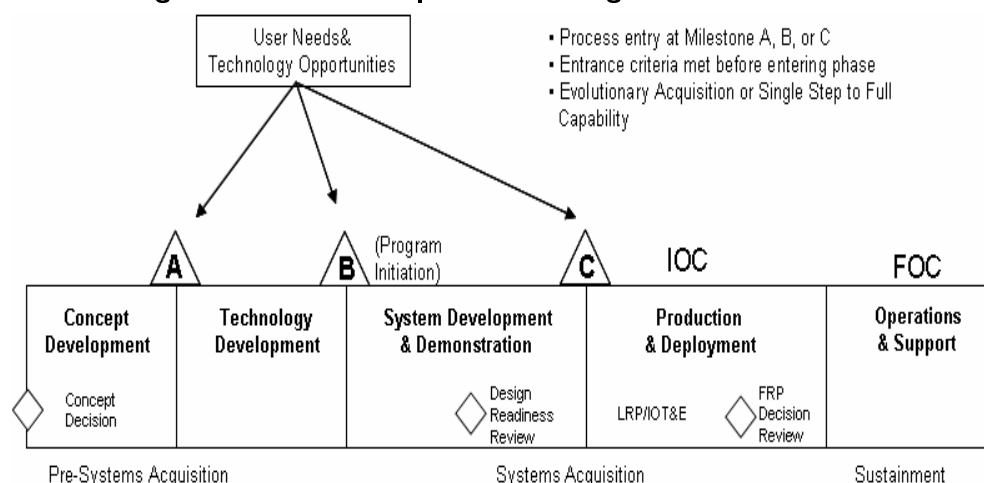
The JSF is in its seventh year of System Development and Demonstration (SDD). **Figure 2**, below, from DOD Instruction 5000.2, *Operation of the Defense Acquisition System*, depicts graphically the acquisition system and where SDD fits into the process.<sup>25</sup>

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<sup>23</sup> Summaries of DOD's Select Acquisition Reports can be found at <http://www.acq.osd.mil/ara/am/sar/index.html>.

<sup>24</sup> See Conference Report (110-477) to accompany H.R. 1585. See CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*, by Anthony Murch and Christopher Bolkom for more information about the F-136 Alternate Engine Program.

<sup>25</sup> JSF program milestones: Concept Development (CDP) in November 1996. Milestone B reached on October 2001, with program successfully completed the CDP exit criteria. Critical Design Review for the CTOL and STOVL variants were completed in February 2006, with the Defense Acquisition Board approving Low Rate Initial Production (LRIP) in March 2006.

**Figure 2. Defense Acquisition Management Framework**

Like some other aviation procurement programs, the JSF has experienced cost growth, schedule slippage, and a reduction in production rates. For example, to address growing weight-driven performance problems encountered early in SDD, DOD extended the SDD phase one year and correspondingly delayed the F-35's scheduled first flight from late 2005 to the summer of 2006 (first flight occurred on December 15, 2006); the beginning of low-rate initial production shifted from 2006 to 2007. Currently, SDD developmental flight testing will conclude October 2012 and the SDD contract period of performance will end a year later.<sup>26</sup>

In June 2005, DOD officials reported that weight reduction efforts were successful and approved the revised development schedule.<sup>27</sup> Extending SDD and producing aircraft at lower annual rates, however, contributed to increased unit cost growth. Rather than request additional funding, JSF program officials instead paid these costs by spending approximately four-fifths of its \$2 billion in "management reserves."<sup>28</sup> Faced with an impending contract over-run, DOD cut two test aircraft from the F-35 program and reduced the number of SDD flight tests.<sup>29</sup> The goal of these cost-saving measures was to help bring the management reserve account back up to about \$1 billion, which is considered an acceptable amount to complete flight testing.

The JSF is expected to remain in production at least through the 2030s. Current plans call for the JSF to be manufactured in several locations. Lockheed Martin will build the aircraft's forward section in Fort Worth, TX. Northrop Grumman will build the mid-section in Palmdale, CA, and the tail will be built by BAE Systems in the United Kingdom. Final assembly of these components will take place in Fort Worth. Italy is working with Lockheed Martin and the Joint Program Office on the potential of erecting a second final assembly and checkout facility in Italy.<sup>30</sup>

<sup>26</sup> IOT&E will conclude in October 2013 bringing SDD to a close.

<sup>27</sup> Marc Selinger, "DoD Approves detailed 're-plan' for Joint Strike Fighter," *Aerospace Daily & Defense Report*, June 2, 2005.

<sup>28</sup> Management reserves are funds set aside to mitigate risk during development.

<sup>29</sup> "Pentagon Trims JSF Test Program." *Aviation Week & Space Technology* December 3, 2007.

<sup>30</sup> Michael Sirak, "F-35 Program May Get First International Orders In Third Production Lot in 2009," *Defense Daily* (continued...)

## Production Quantities<sup>31</sup>

In 1996, preliminary planning estimated over 3,000 aircraft: 2,036 for the Air Force, 642 for the Marines, 300 for the U.S. Navy, and 60 for the Royal Navy. In May 1997, however, the QDR recommended reducing projected procurement for the U.S. armed forces from 2,978 JSF aircraft to 2,852: 1,763 for the Air Force, 609 for the Marines, and up to 480 for the Navy.<sup>32</sup> Thus, the program would comprise 2,912 aircraft (2,852 U.S. and 60 UK JSFs), based on these recommendations. Procurement profiles for all variants and purchasing agencies are shown in **Appendix B** of this report.

In 2003 the Department of the Navy (DON) reduced its planned procurement of 1,089 F-35s to 680 aircraft as part of the Navy/Marine Corps Tactical Aviation Integration Plan.<sup>33</sup> In the spring of 2008, DON officials announced that under current plans, a current shortfall in fighter aircraft of 15 aircraft would grow to a deficit of over 90 aircraft by FY2017.<sup>34</sup> It is unclear what impact this potential, projected shortfall might have on the DON's JSF procurement plans.

Congress and DOD may have occasion to revisit the Air Force's F-35 procurement plans. In hearings on the Air Force's FY2009 budget request, Air Force leaders testified that due to new estimates of the life of the legacy fighter force, the current F-22 and JSF procurement plans would likely leave a gap of up to 800 fighter aircraft by the year 2024.<sup>35</sup>

Since the JSF is a long-term program, projected quantities are more subject to change than in the case of aircraft already in full-rate production. Near-term reductions in quantity could be made up in future years, either through increased U.S. purchases or through foreign sales. However, concerns have been raised that near-term quantity reductions could scare off foreign participation and raise the aircraft's unit price. The GAO views the budget and schedule changes to the JSF program in a more negative light. In March 2005, GAO wrote that the original business case for the aircraft "unexecutable," in large part because of decreased numbers of aircraft to be procured.<sup>36</sup>

## Potential F-35 Bases

In October 2006, Air Force officials indicated the six tentative locations where F-35s would be based. These locations were Nellis AFB, NV; Edwards AFB, CA; Hill AFB, UT; Eglin AFB, FL;

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(...continued)

*International*, June 22, 2007.

<sup>31</sup> See Appendix B for proposed procurement quantities through FY2034 (the last planned procurement year for the United States).

<sup>32</sup> Quadrennial Defense Review Cuts Procurement in FY1999, 2000, *Aerospace Daily*, May 20, 1997, p. 280.

<sup>33</sup> See CRS Report RS21488, *Navy-Marine Corps Tactical Air Integration Plan: Background and Issues for Congress*, by Christopher Bolkcom and Ronald O'Rourke for more information on the DON plan.

<sup>34</sup> See CRS Report RS22875, *Navy-Marine Corps Strike-Fighter Shortfall: Background and Options for Congress*, by Christopher Bolkcom for more information on this potential shortfall in DON fighters.

<sup>35</sup> Lieutenant General Daniel Darnell, Deputy Chief of Staff Air, Space and Information Operations, Plans and Requirements. "Senate Armed Services Subcommittee on Airland Holds Hearing on the Fiscal 2009 Budget for Air Force and Navy Aviation Programs." Congressional Quarterly. Congressional Transcripts. April 9, 2008. p. 16

<sup>36</sup> GAO-05-271, March 15, 2005.

Shaw AFB, SC; and Kadena Air Base, Japan. The Air Force is now awaiting environmental studies before making a final determination. The Marine Corps has tentatively indicated that MCAS Beaufort, MCAS Yuma, MCAS Iwakuni, MCAS Miramar, and MCAS Cherry Point will be the bases for the F-35, again pending their environmental studies and approval of the basing plan.

Basing decisions for the JSF may be of interest to many in Congress. The F-35 is thought by many to be the last manned aircraft that DOD is likely to develop for some time and is projected to be in service long after other combat aircraft have been retired. Those wishing to keep military bases relevant, and to potentially “BRAC-proof” them, may compete vigorously for the JSF.

Determining where a new weapon system is to be based is always a complicated decision with pros and cons for the adjacent civilian community. In February 2009, the Air Force announced that it would bed-down only 59 of the 107 F-35s planned for Eglin, AFB and would restrict F-35 flight operations due to the civilian community’s concerns about noise levels. A supplemental environmental impact statement (SEIS) will be performed before final decisions are made on F-35 basing and operations at Eglin.<sup>37</sup>

## **Allied Participation**

Allied participation in the JSF development program has been actively pursued as a way to defray some of the cost of developing and producing the aircraft, and to “prime the pump” for export. Congress insisted from the outset that the JAST program include ongoing efforts by the Defense Advanced Research Projects Agency (DARPA) to develop more advanced STOVL aircraft, opening the way for British participation. From the Allied perspective, they saw the F-35 as an affordable avenue to acquiring a fifth-generation fighter, technical knowledge such as stealth, and industrial opportunities for domestic firms. The two JSF developmental phases where international participation has been offered are (1) Systems Development and Demonstration (SDD) and (2) Production, Sustainment and Follow-On Development (PSFD). Initial Operational Test and Evaluation (IOT&E), a subset of SDD, is another area that partner nations are assisting the program with. Within each of these phases, the level of participation and funding drives the amount of influence the respective nation can wield.

### **System Development and Demonstration (SDD)**

Eight countries, from 2001 to 2002, signed on to the JSF program to support the anticipated 10-year SDD phase. Partnership was broken down into three levels, by the size of monetary contributions to the program. The higher the investment level, the greater the nation’s voice with respect to aircraft requirements, design, and access to technologies gained during development.

The United Kingdom is the only “Level 1” partner contributing approximately \$2 billion to this phase. UK participation actually began at program outset. On December 20, 1995, the U.S. and UK governments signed a memorandum of understanding (MOU) on British participation in the JSF program as a collaborative partner in the definition of requirements and aircraft design. This MOU committed the British government to contribute \$200 million towards the cost of the 1997-

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<sup>37</sup> “Record of Decision signed on beddown of Joint Strike Fighter.” *Air Force News*. February 6, 2009. and email to congressional staff from SAF/LLW, February 6, 2009.

2001 concept demonstration phase.<sup>38</sup> On January 17, 2001, the United States and United Kingdom finalized the UK's SDD participation, which equated to approximately 8% of the total SDD program. Program proponents noted the UK's signature represented "strong international affirmation of the JSF concept," even though prime contractor competition and selection had not been completed.<sup>39</sup> Many UK firms, such as British Aerospace and Rolls-Royce, have strong participation in the program.

Level II partners consist of Italy and the Netherlands, contributing \$1 billion and \$800 million, respectively. On June 24, 2002, Italy became the senior Level II partner, with the goal of replacing its leased US F-16s and complimenting its Eurofighter Typhoons, and occupies five positions within the Joint Program Office.<sup>40</sup> Italy has been pushing to have its own final assembly line, in addition to the possibility of a maintenance and upgrade facility. The Netherlands signed on to the program on June 17, 2002, after it had conducted a 30-month analysis of potential alternatives. The Dutch see their participation in JSF as a boost to its standings as a maintenance, repair, and overhaul hub in Europe.<sup>41</sup>

The remaining nations of Australia, Denmark, Norway, Canada, and Turkey signed on to the JSF program as Level III partners, with contributions ranging from \$125 million to \$175 million. While contributions are less than their Level I and II partners, the benefit to all nations who participate is a strong commitment by the U.S. to export the aircraft to partner countries once the JSF is in production.<sup>42</sup> Turkish officials have stated that participation in the JSF program is a "major opportunity for our defense industry."<sup>43</sup>

### **Foreign Military Sales (FMS)**

JSF program managers also offer FMS-level of participation for those countries unable to commit to partnership in the JSF's SDD phase. Israel and Singapore are believed to have contributed \$50 million each, and they are "Security Cooperative Participants." This relationship provides "specific case scope outside the cooperative development partnership."<sup>44</sup> In October 2008 it was reported that the Bush administration had authorized sale of the F-35 to Israel,<sup>45</sup> and that Tel Aviv was prepared to spend as much as \$15 billion to procure 25 F-35s.<sup>46</sup> JSF officials have discussed the aircraft with the defense staffs of many other allied countries as prospective customers, including Germany, Greece, and Spain. The Polish government is reportedly leaning toward an FMS investment of \$75 to \$100 million in the JSF program.<sup>47</sup>

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<sup>38</sup> "U.S., U.K. Sign JAST Agreement," *Aerospace Daily*, December 21, 1995, p. 451.

<sup>39</sup> Eric Tegler, "International Instrument: Building the F-35 In Partnership," *F-35 Lightning II Commemorating First Flight*, p. 71.

<sup>40</sup> "F-35 Joint Strike Fighter (JSF) Lightning II: International Partners," <http://www.globalsecurity.org/military/systems/aircraft/f-35-int.htm>, accessed on October 3, 2007.

<sup>41</sup> Tegler, pp. 74-75.

<sup>42</sup> "Australia, Belgium Enter Joint Strike Fighter Program as EMD Partners," *Inside the Air Force*, April 21, 2000.

<sup>43</sup> Bekedil, Burak Ege and Umit Enginsoy, "Turks to Pay up to \$1 Billion to Join JSF Development," *Defense News*, July 17, 2000, p. 6.

<sup>44</sup> Selected Acquisition Report. Office of the Secretary of Defense for Acquisition. December 31, 2005.

<sup>45</sup> Caitlin Harrington. "US approves F-35 sale to Israel." *Jane's Defense Weekly*. October 1, 2008.

<sup>46</sup> "Israel Looks to Spend \$15 Billion for CTOL Variant of F-35." *Defense Daily*. October 1, 2008.

<sup>47</sup> Grzegorz Holdanowicz, "Poland Steps Up Interest in JSF," *Jane's Defense Weekly*, July 18, 2001.

### **Production, Sustainment, and Follow-On Development (PSFD)**

Unlike the SDD phase, PSFD will not make any distinction as to “levels.” In signing the PSFD MOU, partner nations state their intentions to purchase the JSF, and in what quantity and variant, and a determination is made as to their delivery schedule. The governance structure of the program has broadened to allow all participating nations to have a voice in follow-on development decisions. PSFD costs will be divided on a “fair-share” based on the programmed purchase amount of the respective nation. Also, unlike the bilateral SDD MOUs, PSFD is an agreement among all partner nations. Program executives noted the difficulty in coming to an agreement on PSFD because of the expectancy of “offset” arrangements within the agreement.<sup>48</sup> Offset arrangements, considered the norm in defense contracts with foreign nations, usually require additional incentives to compensate the purchasing nation for the agreement’s impact to its local workforce.<sup>49</sup> JSF executives decided to take a different approach, in line with the program’s goal to control costs, to avoid offsets and promote competition as much as possible. All partner nations have agreed to compete for work on a “best-value” basis and have signed the PSFD MOU.

### **Initial Operational Test and Evaluation (IOT&E)**

Currently, the UK, Italy, and the Netherlands have agreed to participate in the IOT&E program. UK, the senior JSF partner, will have the strongest participation in the IOT&E phase. Italy and the Netherlands are contributing a far smaller amount and will take part only in the coalition concept of operations (CONOPS) validation testing.<sup>50</sup> Other partner nations are still weighing their option to participate. The benefits to participation are expedited acquisition of aircraft, pilot training for the test cycle, and access to testing results.

## **Current Issues**

The F-35 presents numerous potential issues for Congress. The F-35 program’s size, its international scope, and its competing objectives for performance, cost effectiveness, and commonality combine to make it arguably the most challenging defense acquisition program ever. A discussion of the most pertinent issues appears below. These issues are not mutually exclusive and overlap along several dimensions.

### **Concurrency of Testing and Production**

The 2005 National Defense Authorization Act directed the GAO to conduct annual reviews of the JSF program to assess the SDD’s meeting of key cost, schedule, and performance goals.<sup>51</sup> In March 2006, the GAO issued its second report highly critical of the JSF testing and production schedule.<sup>52</sup> GAO asserted that the amount of overlap between testing and production in the JSF

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<sup>48</sup> Tegler, p. 79.

<sup>49</sup> Travis Taylor, “An Empirical Evaluation of Offset Arrangements,” University of Richmond, July 2001, p. 6.

<sup>50</sup> Telephone conversation with OSD/AT&L, October 3, 2007.

<sup>51</sup> P.L. 108-375; 118 Stat 1833; October 28, 2004.

<sup>52</sup> *Joint Strike Fighter: DoD Plans to Enter Production before Testing Demonstrates Acceptable Performance* (GAO-06-356), Government Accountability Office, March 2006.

program is risky and could lead to considerable cost growth in the future. GAO noted that the JSF program was to begin low-rate initial production (LRIP) before 1% of flight tests had been completed. GAO noted that up to 424 F-35 aircraft may be built, at a cost of \$49 billion, before development testing is complete. The JSF program intends to make initial production orders on a cost reimbursement contract, “placing an unusually high risk burden on the government during the early production phase.”<sup>53</sup> GAO recommended adopting a more evolutionary approach to developing and producing the F-35, similar to the block upgrade approach pursued successfully in the F-16 program.

The Office of the Secretary of Defense (OSD) has countered GAO’s assertions, noting that GAO’s recommended block development approach would extend SDD by up to eight years, with an associated cost of approximately \$13 billion (in then-year dollars).<sup>54</sup> While GAO’s approach would delay fielding of the F-35, OSD noted that there was no GAO analysis as to the costs of legacy fleet extensions or procurement price increases. The JSF Joint Program Office noted that program acquisition strategy was designed to take advantage of knowledge gained from the F-22 program and legacy programs along with improvements in modeling and simulation to reduce the development period.<sup>55</sup> While this strategy presents increased program risk, proponents note projected cost savings as a result of an expedited testing cycle and retirement of legacy systems. Proponents also highlight that fixes discovered during a more concurrent (i.e., expedited) testing/production cycle are usually much less expensive than the costs associated with a more exhaustive testing period, with less overlap and extended production period. This argument is strengthened somewhat by a Defense Aerospace case study that determined continuity in development is the best way to avoid cost overruns.<sup>56</sup> Programs that are able to manage developmental issues without lengthy program “freezes” were more apt to keep production cost growth to a minimum.

This issue may become acute for the 111<sup>th</sup> Congress. Numerous press reports indicate that DOD hopes to accelerate F-35 purchases from FY2010 through at least FY2015 in an attempt to achieve near term cost savings and to stabilize the aircraft’s per-unit price. Increasing the rate of production while holding the test program static, or even reducing test program assets (see next section) will bring the debate over the concurrency of testing and production into sharp relief.<sup>57</sup>

## **Mid-Course Risk Reduction Plan**

In December 2007 DOD announced that it had decided to cut two test aircraft from the JSF program.<sup>58</sup> Other changes to the test program included foregoing intermediate flight test measurements, reducing the number of flight tests, and employing ground laboratories and flying test beds (non-JSF aircraft instrumented to simulate the F-35) instead of actual JSF aircraft.<sup>59</sup>

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<sup>53</sup> Ibid., p. 6.

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DOD Information Paper for SASC PSM’s Stan O’Connor and Creighton Greene in response to GAO-06-356, June 17, 2006.

<sup>55</sup> Background information provided by JSF Joint Program Office, September 2007.

<sup>56</sup> “Sticker Shock: Estimating the Real Cost of Modern fighter Aircraft,” *Defense-Aerospace.Com*, 2006, p. 3.

<sup>57</sup> See for example: “Fighter Boost,” *Aerospace Daily & Defense Report*, January 20, 2009.

<sup>58</sup> “Pentagon Trims JSF Test Program,” *Aviation Week & Space Technology*, December 3, 2007.

<sup>59</sup> Michael Fabey, “Raptor Stealth Maintenance, JSF Testing Questioned by DOT&E,” *Aerospace Daily & Defense Report*, February 25, 2008.



DOD calls these changes to the F-35 flight test program the “Mid-Course Risk Reduction Plan.” The purpose of the plan is to save approximately \$600 million and replenish management reserves, a pot of money saved to mitigate unforeseen developments in the development program. These reserves had been depleted by program officials who needed to pay escalating program costs.

Opponents to the Mid-Course Risk Reduction Plan argue that it *adds* risk to a program already facing excessive risk due to the overlap between development and production described above. Generally speaking, opponents believe that this plan is detrimental to the test program and raises the risk that design and performance shortcomings will not be discovered until late in the process, when it will be more costly to redress them. Specifically, opponents note that the number of JSF flight tests planned has been reduced twice prior to the Mid-Course Risk Reduction Plan. In October 2005, DOD planned 6,979 F-35 flight tests. Currently, only 5,147 are planned.<sup>60</sup> Further, eliminating two test aircraft, it is argued, removes an important hedge against potential attrition. If something were to go awry with one or more of the test aircraft, fewer are available to take up the slack.

Proponents of this move state that test flights would have been reduced regardless of the status of the management reserve account, owing to testing efficiencies gained through commonality and lab investments. Proponents also assert that arguments against this plan are based on old models of Test & Evaluation. The JSF, they say, is implementing state-of-the-art technological advances in aircraft instrumentation and simulation, which reduces the need for actual flight tests. According to the JSF program manager, these highly integrated test laboratory systems have created a unique test program: “The flight test for the F-35 is, for the first time, verification of projected performance and not discovery-oriented.”<sup>61</sup>

## **Affordability**

Much has been made about the F-35’s overall price tag of almost \$300 billion (TY\$). In addition to the aggregate amount of funding required, several other affordability issues stand out.

First, as the production phase of the F-35 accelerates, the program will require large and sustained expenditures at the same time DOD is facing acute budgetary challenges. Over the next 20 years, DOD projects spending over \$10 billion annually on the F-35.<sup>62</sup> At the same time, DOD aims to recapitalize other aircraft fleets, such as tankers; increase the Army and Marine Corps personnel end-strength; and prosecute the wars in Iraq and Afghanistan. In other words, the *timing* of F-35 program costs may be as big of a challenge as the overall amount.

Second, as the competing funding requirements described above collide, both DOD and Congress may be tempted to reduce the overall number of F-35s to be procured. Experience suggests that reducing multiple defense acquisition programs is more feasible than cancelling one. Planned procurement quantities of the F-22 and the F/A-18E/F, for example, have been reduced by 70% and 54%, respectively. Procuring fewer aircraft reduces overall costs but increases the aircraft’s

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<sup>60</sup> “Joint Strike Fighter: Recent Decisions By DOD Add to Program Risks.” Government Accountability Office. (GAO-08-338) March 2008. p.16.

<sup>61</sup> “Joint Strike Fighter - the latest hotspot in the US defence meltdown.” *Jane’s Defence Weekly*. September 5, 2008.

<sup>62</sup> F-35 (JSF). Selected Acquisition Report (SAR). Office of the Secretary of Defense (AT&L) December 25, 2007. p.15-21.

per-unit cost. This would be particularly detrimental to a program such as the F-35, which was designed specifically to be moderately priced.

Third, there are strong differences of opinion over how F-35 costs are calculated and presented. DOD's latest estimate of the F-35 program, for example, shows the overall cost decreasing from \$299 billion in December 2006 to \$298 billion in December 2007. Some suggest that these figures are misleading, because the largest "savings" reported by DOD in its latest report were not achieved by improvements in design or manufacture, but instead were achieved by a moving costs from one category to another.<sup>63</sup> The GAO offered strong criticism of JSF cost estimates, writing that they were not comprehensive, not accurate, not well documented, nor credible.<sup>64</sup> In summary, GAO noted that the JSF cost estimates did not include \$7 billion for the F136 engine, and that the official JSF cost estimates are at odds with estimates made by three independent DOD agencies. JSF supporters dispute the GAO's findings, arguing that the program office's cost models are more reliable than those used by other organizations.<sup>65</sup> GAO is not the only organization to question the JSF cost estimates. An internal DOD organization – the Joint Estimate Team or JET – argues that the JSF program will cost \$15 billion more than official DOD cost projections.<sup>66</sup>

Fourth, there are a number of factors that will influence JSF costs, either positively or negatively, which are difficult to predict. By statute, DOD must pursue the JSF F136 Alternate Engine program. As mentioned above, GAO notes that the F136 development costs are not included in current JSF cost estimates. The larger question is whether these costs, included or not, will be recouped by competition between the F135 and the F136 during JSF production and operation.<sup>67</sup> Also, the DON has not yet determined how many of its 680 F-35s will be CV variants and how many will be STOVL variants. These aircraft have different operational capabilities, and different production and operating costs. Finally, JSF program officials anticipate major savings because of a high degree of commonality in components and systems among the three versions, which are to be built on a common production line. However, the F-35 is not meeting its goals for commonality, and as the program wrestles with final development challenges, commonality could be compromised further, which would lead to cost increases.<sup>68</sup>

## **Projected Fighter Aircraft Inventory Shortfalls**

In the late winter and early spring of the FY2009 legislative cycle, both Air Force and Department of the Navy (DON) officials testified that they were facing a projected "fighter gap." Because of high combat aircraft utilization rates in Afghanistan and Iraq, legacy air forces (A-10s, F-15s, F-16s, F/A-18s) were wearing out faster than previously predicted, while new aircraft procurement (e.g., F-22A, F-35, F/A-18E/F) remained steady or had declined. At its worst, DON

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<sup>63</sup> David Fulghum. "Dueling Analyses; Questions Remain About the Fundamental Soundness of Top Pentagon Programs." *Aviation Week & Space Technology*. April 14, 2008.

<sup>64</sup> GAO-08-388. summarized on pp. 3-4 and addressed in detail throughout the report.

<sup>65</sup> Amy Butler. "Cost Question." *Aviation Week & Space Technology*. July 14, 2008

<sup>66</sup> Marcus Weisgerber. "'Independent' DOD Assessment Finds JSF Underfunded by \$15 Billion." *Inside the Air Force*. November 28, 2008.

<sup>67</sup> See CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*, by Anthony Murch and Christopher Bolkcom for more information on the F136 engine program.

<sup>68</sup> GAO-08-388. p. 10.

officials projected a deficit of more than 90 aircraft in FY2017-FY2020.<sup>69</sup> Air Force officials projected a potential gap of up to 800 fighter aircraft by the year 2024.<sup>70</sup>

These projections could affect the F-35 program in a number of different ways. DOD officials could, for example, accelerate F-35 procurement and increase the total number to be procured. The Marine Corps seeks a dedicated stand-off jamming aircraft to replace its aging EA-6B *Prowlers*. JSF aircraft of current design, or JSF's augmented to perform the electronic attack mission more effectively are two options being considered for this mission. If the Marine Corps were to use the F-35 for this mission, it could argue for a larger JSF inventory.<sup>71</sup>

Also, Air Force officials have testified that they wish to double F-35 purchases over the next five years to alleviate the projected shortfalls.<sup>72</sup> Although accelerating F-35 purchases may appear beneficial to the program's supporters, it might also have negative consequences. JSF officials have stated that to meet the current schedule, they may be forced to field less capable STOVL aircraft and upgrade them at later dates. It is not clear what effect this block upgrade approach would have on overall costs.<sup>73</sup>

Another way to address the projected fighter shortfall would be to purchase more F-15s, F-16s, F/A-18E/Fs, and F-22s, all of which are still in production. The Navy, reportedly, is considering procuring 69 more Super Hornets to close the fighter gap.<sup>74</sup> This option might be cheaper than purchasing more F-35s, although these aircraft are less capable than the F-35. (The F-22 is the exception in this comparison because it is more expensive than the F-35 and more capable in many dimensions.) Additional purchases of these aircraft, however, especially if at the F-35's expense, could raise F-35 unit cost and potentially alienate foreign partners, who are already concerned about cost growth in the JSF program.<sup>75</sup>

A similar option would be to execute a service life extension (SLEP) program for those aircraft that are wearing out prematurely. This option may prove to be cheaper than purchasing new aircraft. However, SLEPping aircraft keeps them in depot and unavailable for operations for months, if not years, which can constrain military capabilities and place even greater pressure on those aircraft still flying.

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<sup>69</sup> See CRS Report RS22875, *Navy-Marine Corps Strike-Fighter Shortfall: Background and Options for Congress*, by Christopher Bolkcom for more information.

<sup>70</sup> Lieutenant General Daniel Darnell, Deputy Chief of Staff Air, Space and Information Operations, Plans and Requirements. "Senate Armed Services Subcommittee on Airland Holds Hearing on the Fiscal 2009 Budget for Air Force and Navy Aviation Programs." Congressional Quarterly. Congressional Transcripts. April 9, 2008. p.16

<sup>71</sup> See, for example: David Fulghum. "Electronic Attack Variant of F-35 Faces Services' Indecision." *Aerospace Daily & Defense Report*. November 25, 2008; Dan Taylor "Heinz" Airborne Electronic Attack Could Be One of Many JSF Abilities." *Inside the Air Force*. December 19, 2008; David Fulghum. "F-35 to Become Electronic Attack Aircraft." *Aviation Week & Space Technology*. December 1, 2008. and "Amy Butler. "Major Budget Changes Expected after QDR." *Aerospace Daily & Defense Report*. February 2, 2009.

<sup>72</sup> John Reed. "Air Force Working To More Than Double The Pace Of F-35 Purchases." *Inside the Air Force*. July 25, 2008.

<sup>73</sup> Dan Taylor. "Heinz: JSF Program Prepared to Trim Aircraft to Stay On Schedule." *Inside the Air Force*. July 11, 2008.

<sup>74</sup> Philip Ewing. "New Hornets Could Fill Void Until F-35s Arrive." *Navy Times*. March 17, 2008.

<sup>75</sup> Gregor Ferguson. "JSF Partners Meet to Talk Initial Price, Orders." *Defense News*. June 9, 2008.

A final option to address the projected fighter gap would be to do nothing. By sticking with the current fighter aircraft procurement plans, DOD may end up reducing the overall inventory of combat aircraft. This may be a risk that is worth taking, considering other U.S. aviation capabilities such as bombers, cruise missiles, and armed-UAVs, and the lack of perceived threats. On the other hand, today's relatively large inventory of fighter aircraft is well-worn from excessive use. There is no reason to think that tomorrow's smaller fighter aircraft inventory would not experience equally high operations tempo.

## **Implications for U.S. Defense Industry**

As DOD's largest single weapon system acquisition program, the JSF is a focal point for discussions regarding the U.S. defense industrial base. The October 2001 award of the JSF Engineering Manufacturing Development (EMD) contract to a single company (Lockheed Martin) raised concerns in Congress and elsewhere that excluding Boeing from this program would reduce that company's ability to continue designing and manufacturing fighter aircraft. This, in turn, would have a negative effect on the U.S. defense industrial base.<sup>76</sup>

Similar concerns were raised in 2006 when DOD proposed terminating the F136 Alternate Engine. In this case, some worried that if the F136 were cancelled, General Electric (GE) would not have enough business designing and manufacturing fighter jet engines to continue competing with Pratt & Whitney (the manufacturer of the F135 engine) in the future. This would leave the United States dependent on only one domestic manufacturer of this class of engine. Others argued that GE's considerable business in both commercial and military engines was sufficient to sustain GE's ability to produce this class of engine in the future.<sup>77</sup>

The JSF program could also have a strong impact on the U.S. defense industry through export. Most observers believe that the JSF could potentially dominate the combat aircraft export market much as the F-16 has. Like the F-16, the JSF appears to be attractive because of its relatively low cost, flexible design, and promise of high performance. Also, analysts note that during his first stint as Defense Secretary, Donald Rumsfeld played an instrumental role in launching the F-16 program by including foreign partners in the aircraft's development.<sup>78</sup> Many competitors, including France's Rafale, Sweden's JAS Gripen, and the European Typhoon, are positioned to challenge the JSF in the fighter export market, or take its market share if the program is cancelled. Also, few countries have expressed interest in buying either the F-22A or the F/A-18E/F. The one country that has expressed interest in the F-22A, Japan, will most likely be unable to procure the F-22 because of a proposed clause in the FY2008 Appropriations bill upholding a ban on F-22 exports.<sup>79</sup> Instead, Japan is being redirected towards the F-35.

It can also be argued that the demand for civilian transport aircraft after 2000 will be strong enough to sustain a robust U.S. aviation industry, given the need to replace aging aircraft with quieter and more fuel-efficient planes for expanding domestic and international travel markets.

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<sup>76</sup> For more information, see CRS Report RL31360, *Joint Strike Fighter (JSF): Potential National Security Questions Pertaining to a Single Production Line*, by Christopher Bolcom and Daniel H. Else.

<sup>77</sup> For more information, see CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*, by Anthony Murch and Christopher Bolcom.

<sup>78</sup> Vago Muradian, "Coffman: JSF Critical to Preserving U.S. Leadership in World Fighter Market," *Defense Daily*, February 26, 2001.

<sup>79</sup> "US Decides to Keep Export Ban on F-22 Stealth Fighter," Jiji Press Ticker Service, July 26, 2007.

For example, the worldwide fighter/attack market in 2005 has been estimated to be worth about \$13.2 billion, while the commercial jet transport market is projected to be worth about \$43.5 billion at that time. Compared with its European and Asian competitors, the U.S. aviation industry appears to be well-positioned to meet the needs of an expanding world market for civil aircraft after the turn of the century.<sup>80</sup> The extent to which such economic conditions may preserve an adequate U.S. defense industrial base for the development and production of combat aircraft is debatable, however, given the significant differences between civilian and military aircraft requirements and technologies.

Others fear that by allowing foreign companies to participate in this historically large aircraft acquisition program, DOD may be inadvertently opening up U.S. markets to competitors who enjoy direct government subsidies. These government subsidies could create an unfair advantage for them relative to U.S. companies, it is argued, and the result could be the beginning of a longer-term foreign penetration of the U.S. defense market that could erode the health of the U.S. defense industrial base. In May 2004, the GAO release a report that found the JSF program could “significantly impact” the U.S. and global industrial base.<sup>81</sup> The GAO found that two laws designed to protect segments of the U.S. defense industry, the Buy American Act and the Preference for Domestic Speciality Metals clause, would have no impact on decisions regarding which foreign companies would participate in the JSF program. This is because DOD has decided that foreign companies that participate in the JSF program, and which have signed reciprocal procurement agreements with DOD to promote defense cooperation, are eligible for a waiver.

Program proponents note the economic potential that comes with participation in the program. A 2003 DOD study into international participation concluded that the potential exists for partner nations to earn between \$5 and \$40 of revenue for every \$1 invested through program contracts.<sup>82</sup> Current program policy to eschew offset arrangements will favor governments and corporations that take an aggressive approach to providing “best-value” bids for JSF work. On the positive side, this approach seeks to be the most cost-effective. However, partner countries that cannot compete effectively in this environment could be frustrated by the lack of contracts awarded.

For several years, press reports have indicated that a number of partner nations have threatened to withdraw from the program because of frustrations over workshare and technology transfer issues.<sup>83</sup> As previously discussed, the F-35 program has attempted to break from past “offset” arrangements in an effort to keep costs down. To more effectively negotiate the terms of their involvement, some European F-35 partners are attempting to team with others and present a more united position vis-a-vis Lockheed Martin, the JSF prime contractor.<sup>84</sup>

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<sup>80</sup> Richard Aboulafia, “Market Overviews—Commercial Jet Transports, Fighter/Attack Aircraft,” *World Military and Civil Aircraft Briefing*, Teal Group Corp., March 1997.

<sup>81</sup> General Accountability Office, *Joint Strike Fighter Acquisition: Observations on the Supplier Base*, GAO-04-554, May 2004.

<sup>82</sup> “International Industrial Participation: A Study of Country Approaches and Financial Impacts on Foreign Suppliers,” Office of the Deputy Under Secretary of Defense (Industrial Policy), June 2003.

<sup>83</sup> See “Norway Signs Industrial Partnership with Eurofighter Consortium,” *Defense Daily*, January 29, 2003; Joris Janssen Lok, “Frustration Mounts Among JSF Partners,” *Jane’s Defense Weekly*, March 24, 2004; Thomas Dodd, “Danish Companies Consider Quitting JSF Programme,” *Jane’s Defence Weekly*, January 9, 2004; Tom Kingston, “Unsatisfied Italy May Cut JSF Participation,” *Defense News*, May 10, 2004; Lale Sariibrahimoglu, “Turkey may withdraw from JSF program,” *Jane’s Defence Weekly*, November 10, 2004.

<sup>84</sup> Tom Kingston. “Italy Pushes for Europeanized JSF.” *Defense News*. October 13, 2008.

Technology transfer has also been a problem with the United States' first export of stealth technology. Congress, in the John Warner National Defense Authorization Act for Fiscal Year 2007, sensing United Kingdom frustrations with technology-sharing, advised the Secretary of Defense to share technology consistent with the national security interests of both nations.<sup>85</sup> Program officials note that they are working with partner nations to improve their ability to effectively compete for JSF work and are working with DOD expedite technology-transfer issues.<sup>86</sup> While workshare and technology transfer issues still remain, no country has pulled its support for the F-35 program, and all have signed the Production, Sustainment, and Follow-On Development memorandum. The issue for U.S. policy makers is how to balance legitimate yet often contradictory concerns regarding security, investment, and industrial competitiveness.

## Congressional Action

The Bush Administration's FY2009 budget requested \$6.9 billion in procurement and R&D funding for the F-35. This request is summarized in **Table 1**, below. Changes to the request are highlighted in bold text.

**Table 1. JSF F-35 FY2009 Funding**  
(\$ Millions)

	USN R&D	USAF R&D	USN Proc.	USAF Proc.
Request	1,532.7	1,524.0	(8 aircraft) 1,602 (APCY) 258.8	(8 aircraft) 1,673.7 (APCY) 136.9
Authorization Conf. (S. 3001)	<b>1,780.2</b>	<b>1,771.5</b>	(7 aircraft) <b>1,439.2</b> (APCY) 258.8	(7 aircraft) 1,504.2 (APCY) 171.9
Appropriations Conf. (H.R. 2638)	<b>1,909.7</b>	<b>1,899</b>	(6 aircraft) <b>1,252.4</b> (APCY) 258.8	(6 aircraft) <b>1,243.5</b> (APCY) 171.9

**Note:** APCY = Advanced Procurement (current year).

As it did in FY2007 and FY2008, DOD proposed in FY2009 to cancel the F136 alternate engine. And again, authorization conferees increased the R&D accounts to fund the F136. The defense oversight committees also reduced the number of aircraft to be procured in FY2009. In February 2009 it was reported, however, that the Navy had succeeded in reprogramming \$40 million to purchase long-lead items sufficient to keep its F-35 procurement plans on track.<sup>87</sup>

The Bush Administration's FY2008 budget requested \$6.1 billion in funding for the Joint Strike Fighter. This request is summarized in **Table 2**, below. Changes to the request are highlighted in bold text.

<sup>85</sup>

P.L. 109-364; 102 Stat 2134; October 17, 2006.

<sup>86</sup> Tegler, p. 81.

<sup>87</sup> Amy Butler. "Restored Funds for First F-35Cs Pass Congress." *Aerospace Daily & Defense Report*. February 11, 2009.

**Table 2. JSF F-35 FY2008 Funding**

(\$ Millions)

	<b>USN R&amp;D</b>	<b>USAF R&amp;D</b>	<b>USN Proc.</b>	<b>USAF Proc.</b>
Request	1,707.3	1,780.8	(6 aircraft) 1,112.5 (APCY) 119.5	(6 aircraft) 1,298.1 (APCY) 123.5
Authorization Bill P.L. 110-181 (H.R. 4986, 110-477)	1,805,772	1,879,324	Both bills matched JSF procurement funding requests	
Appropriation Bill P.L. 110-116 (H.R. 3222, 110-435)	1,905,772	2,004,324		

**Note:** APCY = Advanced Procurement (current year).

As it did in FY2007, DOD proposed in FY2008 to cancel the F136 alternate engine. And again, authorization conferees increased the R&D accounts to fund the F136 program. Section 213 of the report requires DOD to develop a competitive engine for the JSF and to continue competition for the engine throughout the F-35's production phase. Appropriations conferees added a total of \$480 million to the Navy and Air Force R&D accounts for the F136 program. Appropriators also added \$200 million to the JSF's R&D budget for affordability initiatives and information assurance, but docked the F-35 \$283 million for excessive award fees and over billing.

The Bush Administration's FY2007 budget requested \$5,290.1 million (\$5.3 billion) in funding for the Joint Strike Fighter. The Air Force requested \$1,015 million in procurement funds to build five aircraft and purchase long-lead items for eight aircraft in FY2008, and \$ 1,999.1 in RDT&E funds. The Navy requested \$245 in advance procurement funds (to build eight F-35B aircraft in FY2008) and \$2,031 in RDT&E funds. Congressional action on this request is summarized in **Table 3**, below. Changes to the request are highlighted in bold text.

**Table 3. JSF F-35 FY2007 Funding**

(\$ Millions)

	<b>USN R&amp;D</b>	<b>USAF R&amp;D</b>	<b>USN Proc.</b>	<b>USAF Proc.</b>
Request	2,031	1,999.1	245	1,015
Authorization Bill P.L. 109-364 (H.R. 5122, 109-702)	2,200	2,170	123	921
Appropriation Bill P.L. 109-289 (H.R. 5631, 109-676)	2,172	2,138	123	489

Both authorizers and appropriators objected to DOD's plan to eliminate the F136 Alternate Engine and added JSF R&D funds to continue the program. Similarly, both authorizers and appropriators expressed concern about program risk, either explicitly or implicitly, reacting to what some to believe to be an excessive overlap between JSF testing and JSF development.

The Bush Administration's FY2006 budget requested \$5,020.0 million (\$5 billion) in funding for the Joint Strike Fighter. The Air Force requested \$152.4 million in advance procurement and \$2,474.8 million in RDT&E funds. The Navy requested \$2,393 million in RDT&E funds. Congressional action on this request is summarized in **Table 4**, below. Changes to the request are highlighted in bold text.

**Table 4. JSF F-35 FY2006 Funding**

(\$ Millions)

	<b>USN R&amp;D</b>	<b>USAF R&amp;D</b>	<b>USAF Proc.</b>
Request	2,393.0	2,474.0	152.4
Authorization Bill P.L. 109-163 (H.R. 1815, 109-360)	2,393.0	2,474.0	152.4
Appropriations Bill P.L. 109-148 (H.R. 2863, 109-359)	2,305.1	2,366.7	120

In cutting JSF funding, the appropriations conference report noted that “excessive program risk remains,”<sup>88</sup> and that “under the revised aircraft build sequence all of these aircraft do not require full funding prior to the beginning of fiscal year 2008.”<sup>89</sup>

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<sup>88</sup> H.R. 2863 (109-359), p. 418.

<sup>89</sup> H.R. 2863 (109-119), p. 172.



## Appendix A. JSF Key Performance Parameters

	KPP	STOVL	CTOL	CV
JOINT	<i>Radio Frequency Signature</i>	Very Low Observable		
	<i>Combat Radius</i>	450 nm USMC Profile	590 nm USAF Profile	600 nm USN Profile
	<i>Sortie Generation</i>	4 Surg / 3 Sust	3 Surg / 2 Sust	3 Surg / 2 Sust
	<i>Logistics Footprint</i>	< 8 C -17 equivalent loads (20 PAA)	< 8 C -17 equivalent loads (24 PAA)	< 46,000 cu ft 243 ST
	<i>Mission Reliability</i>	95%	93%	95%
	<i>Interoperability</i>	Meet 100% of critical, top-level Information Exchange Requirements Secure Voice and Data		
USMC	<i>STOVL Mission Performance</i> <i>Short Take-Off Distance</i>	550'	N/A	N/A
	<i>STOVL Mission Performance</i> <i>Vertical Lift Bring Back</i>	2 x 1K JDAM, 2 x AIM -120 With Reserve Fuel	N/A	N/A
USN	<i>Maximum Approach Speed</i>	N/A	N/A	145 knots

**Notes:** JSF Joint Program Office: October 11, 2007. PAA = Primary Aircraft Authorized, ST = Short Tons, Vertical Lift Bring Back = amount of weapons/fuel that can be safely landed with.

## Appendix B. JSF Procurement Plan

Fiscal Year	USAF	DON (USN & USMC)	International	Annual Total	Cumulative (all years)
2007	2	0	0	2	2
2008	6	6	0	12	14
2009	8	8	3	19	33
2010	12	18	2	32	65
2011	24	19	2	45	110
2012	42	40	30	112	222
2013	48	42	36	126	348
To 2034	1621	547	573	2741	3089

**Note:** F-35 Lightning II Program Brief (April 19, 2007), JSF Program Office.

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